NOTES FOR STUDENTS

Periodicity in tropical trees.—KLEBS[12] has added some important evidence on the much disputed question of the cause of periodicity in tropical trees. It has been observed that some tropical trees in the very nearly constant climate of their native habitat show no vegetative periodicity, while most of them show an alteration of growth and rest in some form or other. VOLKENS and others attribute this behavior or difference in behavior to hereditary characters; while KLEBS thinks of it as the result of external (nutrient) conditions acting upon the specific structure (hereditary characters) of the plants. KLEBS would say that the course of development of any plant or plant primordium is determined by two things, specific structure of the unit and the condition under which it develops. Every such unit has many potentialities so far as course of development is concerned; the one realized depends upon the condition under which it develops. The reviewer feels that the dual nature of the determiners of the course of development of the individual should sink deeply into the minds of all botanists. It will clear away much foggy thinking frequently manifested by such statements as "this character is due to heredity" and "that one to environment." *Every character is due to both.* Here the speculative philosopher's attempt to get at the *one essential factor* fails, for there are two.

The work was done in the greenhouse at Heidelberg on the following forms in the main: *Terminalia Catappa, Theobroma Cacao, Albizzia stipulata,* and *Pithecolobium Saman.* KLEBS states that since growth depends upon a great number of factors, rest can be procured by any one of these sinking to a certain minimum, and this minimum varies greatly for the different species. KLEBS worked especially with light and nutrient salts. The light intensity and its daily durations at Heidelberg gradually fall to a low minimum late in December. With good salt supply there were 3 types of response to this seasonal light minimum: (1) buds were formed and unfolded continuously throughout the year, but the leaves were smaller and their daily growth less during the time of minimum light (*Terminalia, Albizzia, Pithecolobium*); (2) leaves were formed throughout the season, but these did not unfold normally from November to January (*Theobroma*); (3) plants rested during the months of minimum light (*Eriodendron anfractuosum* and probably *Sterculia*).

The growth inhibiting or rest producing effect of diminished light may be shown in summer. This is most marked in complete darkness, which readily throws even *Albizzia* and *Pithecolobium* into rest. *Albizzia* continues to vegetate in darkness if it has much stored food, so that the effect of diminishing light seems to be related to reduced food supply and not to such specific action as KLEBS found for the beech. Limited light and limited salt supply may act together in producing rest. *Albizzia, Pithecolobium,* and *Terminalia* were

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[12] KLEBS, G., Über Wachstum und Ruhe tropischer Baumarten. Jahrb. Wiss. Bot. **56**:734–792. 1915.

thrown into rest periods at the winter period of minimum light if they were pot bound, but not with good salt supply. The part played by specific structure was evident here, for light amounts that produced continuous unfolding in buds of *Terminalia* gave buds that did not unfold in *Theobroma*, and complete rest in *Eriodendron*.

Intense photosynthesis resulting in high carbohydrate supply produces rest if salts are insufficient. One growth period may exhaust the salt supply, thus producing rest which lasts until the salt supply rises because of non-consumption and induces a second growth period. KLEBS suggests that this is the condition that throws into dormancy the buds formed in the spring on trees growing in our climate. The salts have been reduced by the formation of stems and leaves and the carbohydrates are abundant, owing to the activity of the newly formed leaves. He suggests that high photosynthesis along with low salt supply may produce dormancy in a similar way in trees of the tropics Several workers have shown that older individuals of a tropical species are more likely to show a rest period than young ones. This KLEBS attributes not to age so much as to limited nutrients conditioned by a multiplication of buds dependent upon a single absorptive and conductive system.

KLEBS criticizes JOST and SIMON for classifying salts with anesthetics as mere stimuli to growth, rather than thinking of their nutrient significance. He speaks of salt addition as a quantitative increase of an already present and *absolutely necessary growth factor*. In this connection he emphasizes the error of assuming that the soil is a constant factor. In such a complex system of organisms and organic and inorganic materials in ever shifting equilibria one must expect periodic changes in supply of nutrient salts as well as in other factors. The frequently observed fact that different individuals of the same species in the tropics show marked differences in vegetative periodicity may be due to the soil factor.

KLEBS speaks of throwing *Pithecolobium* into rest at will (by salt reduction) or active growth (by salt addition) with the same sort of ease as *Vaucheria* can be caused to reproduce by zoospores on the one hand, or by oospores on the other; or water to assume the form of a solid under one condition and that of a liquid under another condition. His evidence leaves little doubt that the tropical trees in general can be made to behave quite like *Pithecolobium*. It seems that KLEBS has established his general contention of the dual determination of periodicity in these forms, but there are some minor conceptions that are less happy.

He classifies all nutrient salts together as if they all have the same effect upon the course of development, while agriculturists have fully demonstrated that nitrates and phosphates in some respects have opposite effects. He implies that salts have their effects mainly as nutrients (building materials), while the extensive work on antagonism probably deals with general physical or colloidal effects, and there is evidence that metallic ions are of importance in catalysis. Moreover, it is not yet shown whether high nitrate supply induces

vegetation and succulence through materials (proteins, etc.) built from it or through its lyotropic effects, and whether the partially contrasting effects of phosphates depend upon the first or second condition. Periodicity in salt absorption which has been observed in trees and grains is also minimized It seems evident that to get far back of the general proposition which KLEBS has apparently proved, there is need of a careful study of internal conditions of the plant, anatomical, chemical, and microchemical, as well as the application (by injection or otherwise) of various salts and carbohydrates and products manufactured from them to be sure of the effective agents.—WILLIAM CROCKER.

Morphology of Gnetum.—THOMPSON[13] has done a much needed service in making a thoroughgoing investigation of *Gnetum*. We have had too meager information in reference to this important and puzzling genus, owing mainly to the difficulty of obtaining material representing any extended and close series of stages. THOMPSON obtained his material during a visit to the Malay Archipelago, and chiefly from the Botanic Garden at Buitenzorg and the adjacent country. As a consequence, he has published an extended account of all the structures related to reproduction. Several species were investigated, and especially two species that represent the extremes of variation. The details are so numerous that they cannot be repeated in a review, but some of the more important facts may be mentioned. Certain strobili were found in which the flowers are arranged in a spiral, and are thus very suggestive of catkins of Amentiferae. In the development of the megasporangium the 3 envelopes arise in acropetal succession, and the micropylar tube, which THOMPSON regards as a style, develops conducting tissue. No vegetative cells appear in the development of the male gametophyte, and the microspores frequently germinate in the micropylar tube at a distance from the nucellus. At fertilization stage the female gametophyte consists of approximately 256 or 512 free nuclei; and after the entrance of the pollen tube rapid divisions occur, multinucleate compartments being formed and all the nuclei in each compartment fusing.

THOMPSON concludes that the strobili of *Gnetum* are closely related to the catkins of the Amentifereae; that the flowers are reduced from a bisporangiate condition; that the inner "envelope" of the ovulate flower is an ovary homologous with that of the angiosperms and bearing a true style (the micropylar tube); that the female gametophyte is gymnospermous in its early stages and angiospermous in the later ones; that the fusion of nuclei preceding endosperm formation is a forerunner of that in angiosperms; that the angiosperms have been derived from ancestors very much like modern Gnetales, and that, in fact, the genus *Gnetum* should probably be classified with angiosperms.—J. M. C.

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[13] THOMPSON, WALTER P., The morphology and affinities of *Gnetum*. Amer. Jour. Bot. 3:135–184. *pls.* 2–7. 1916.